

**Claims**

1. A printed circuit board comprising  
electrical circuitry formed on an outer surface of the printed  
circuit board, the circuitry comprising copper or a copper alloy;  
a final finish on the circuitry, the final finish comprising  
a coating of tin on the copper or copper alloy circuitry; and  
an alloy cap layer on the tin coating, the alloy cap layer  
comprising at least two immersion-platable metals.

2. The printed circuit board of claim 1, wherein the at least  
two immersion-platable metals are selected from tin, silver, bismuth, copper,  
nickel, lead, zinc, indium, palladium, platinum, gold, cadmium, ruthenium and  
cobalt.

3. The printed circuit board of claim 2, wherein one of the  
at least two immersion-platable metals is tin.

4. The printed circuit board of claim 1, wherein the at least  
two immersion platable metals comprise tin and silver.

5. The printed circuit board of claim 1, wherein the tin  
coating has a thickness in the range from about 20 microinches to about 300  
microinches.

6. The printed circuit board of claim 1, wherein the tin  
coating has a thickness in the range from about 40 microinches to about 60  
microinches.

7. The printed circuit board of claim 1, wherein the alloy cap layer has a thickness in the range from about 1 microinch to about 30 microinches.

8. The printed circuit board of claim 1, wherein the alloy cap layer has a thickness in the range from about 2 microinches to about 10 microinches.

9. The printed circuit board of claim 1, wherein the circuitry is substantially free of tin whiskers.

10. The printed circuit board of claim 1, wherein the circuitry remains free of tin whiskers for at least 70 hours at 130°C.

11. The printed circuit board of claim 1, wherein the circuitry remains solderable for at least one year.

12. A printed circuit board comprising  
electrical circuitry formed on an outer surface of the printed circuit board, the circuitry comprising copper or a copper alloy;  
a final finish on the circuitry, the final finish comprising  
a coating of tin on the copper or copper alloy circuitry; and  
an alloy cap layer on the tin coating, the alloy cap layer comprising tin and at least one immersion-platable metal other than tin.

13. The printed circuit board of claim 12, wherein the immersion-platable metal other than tin is selected from silver, bismuth, copper, nickel, zinc, indium, palladium, platinum, gold, cadmium, ruthenium and cobalt.

14. The printed circuit board of claim 12, wherein the tin alloy cap layer comprises from about 50 wt% to about 98 wt% tin.

15. The printed circuit board of claim 12, wherein the tin alloy cap layer comprises from about 80 wt% to about 95 wt% tin.

16. The printed circuit board of claim 12, wherein the at least one immersion platable metal is silver.

17. The printed circuit board of claim 16, wherein the tin alloy cap layer comprises from about 50 wt% to about 98 wt% silver.

18. The printed circuit board of claim 16, wherein the tin alloy cap layer comprises from about 80 wt% to about 95 wt% silver.

19. The printed circuit board of claim 12, wherein the circuitry is substantially free of tin whiskers.

20. The printed circuit board of claim 12, wherein the circuitry remains free of tin whiskers for at least 70 hours at 130°C.

21. The printed circuit board of claim 12, wherein the circuitry remains solderable for at least one year.

22. A printed circuit board comprising  
electrical circuitry formed on an outer surface of the printed circuit board, the circuitry comprising copper or a copper alloy;  
a final finish on the circuitry, the final finish comprising  
a coating of tin on the copper or copper alloy circuitry; and

an alloy cap layer on the tin coating,  
wherein the final finish is formed by a process comprising the  
steps of:

- (A) preparing an immersion tin plating solution;
- (B) applying the immersion tin plating solution to the circuitry  
to form the coating of tin;
- (C) preparing an immersion alloy plating solution containing  
at least two immersion-platable metals;
- (D) applying the immersion alloy plating solution to the  
circuitry to form the alloy cap layer on the coating of tin.

23. The printed circuit board of claim 22, wherein the at least  
two immersion-platable metals are selected from tin, silver, bismuth, copper,  
nickel, lead, zinc, indium, palladium, platinum, gold, cadmium, ruthenium and  
cobalt.

24. The printed circuit board of claim 22, wherein the at least  
two immersion-platable metals comprise tin and silver.

25. The printed circuit board of claim 22, wherein the  
immersion tin plating solution comprises a stannous salt of a hydrocarbyl-  
substituted sulfonic acid, the hydrocarbyl-substituted sulfonic acid, a  
complexing agent and water.

26. The printed circuit board of claim 22, wherein the  
immersion alloy plating solution comprises at least two immersion-platable  
metal salts of a hydrocarbyl-substituted sulfonic acid, the hydrocarbyl-  
substituted sulfonic acid, a complexing agent and water.

27. The printed circuit board of claim 22, wherein following formation of the alloy cap layer, the circuitry is substantially free of tin whiskers.

28. The printed circuit board of claim 22, wherein the circuitry remains free of tin whiskers for at least 70 hours at 130°C.

29. The printed circuit board of claim 22, wherein the circuitry remains solderable for at least one year.

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